


5-27-2013

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Recommended Citation

Bagheri, Fatemeh (2013) "Regulation of Hydraulic Fracturing of Shale Gas Formations in the United States," *Pepperdine Policy Review*: Vol. 6, Article 9.

Available at: <http://digitalcommons.pepperdine.edu/ppr/vol6/iss1/9>

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Regulation of Hydraulic Fracturing of Shale

Gas Formations in the United States

Fatemeh Bagheri

I. The History & Process of Hydraulic Fracturing

Hydraulic fracturing has a long history and was first developed in Sweden in 1878 and was used for offshore drilling during the 1930s. The current version of the hydraulic fracturing technique in existence today was first used in 1947. However, it was not commercially used until 1998 (Cummins, 2012). The practice has been used across the United States and at almost every site that it was introduced; controversy has surrounded the prospects for pursuing the gas extraction project. Hydraulic fracturing has made it possible to extract oil and gas that were economically inaccessible and is used in areas with tight sands, shale, and coal bed methane formations.

A. Brief History

This examination will focus on the practice of hydraulic fracturing technology in extracting shale gas. There are thirty-one states in the continental United States which have significant shale gas reserves or where the oil industry has shown interest in shale gas development (CEEP, 2012). According to the Environmental Working Group, since the year 2000, approximately 120,000 wells were drilled by oil and gas companies and 270,000 wells were drilled since the 1980s (Horwitt, 2009). According to the Energy Information Administration, it is currently estimated “that the U.S. will rely on shale gas for roughly 45% of our energy needs by the year 2035” (Demelle, 2011).

Shale gas extraction occurs in shale formations composed of many thin layers. Shale is a sedimentary rock and is compacted together tightly under natural pressure. The largest hydraulic fracturing opportunities in the U.S. lie in large shale play formations, some of them being Barnett Shale in Texas, Bakken Shale in North Dakota, Haynesville Shale in Louisiana, Marcellus Shale in the Appalachian Basin, and Raton Basin in Colorado (Cummins, 2012). There are large shale plays with smaller, significant shale plays throughout the United States. Figure 1 shows current and prospective shale plays in the lower 48 states.

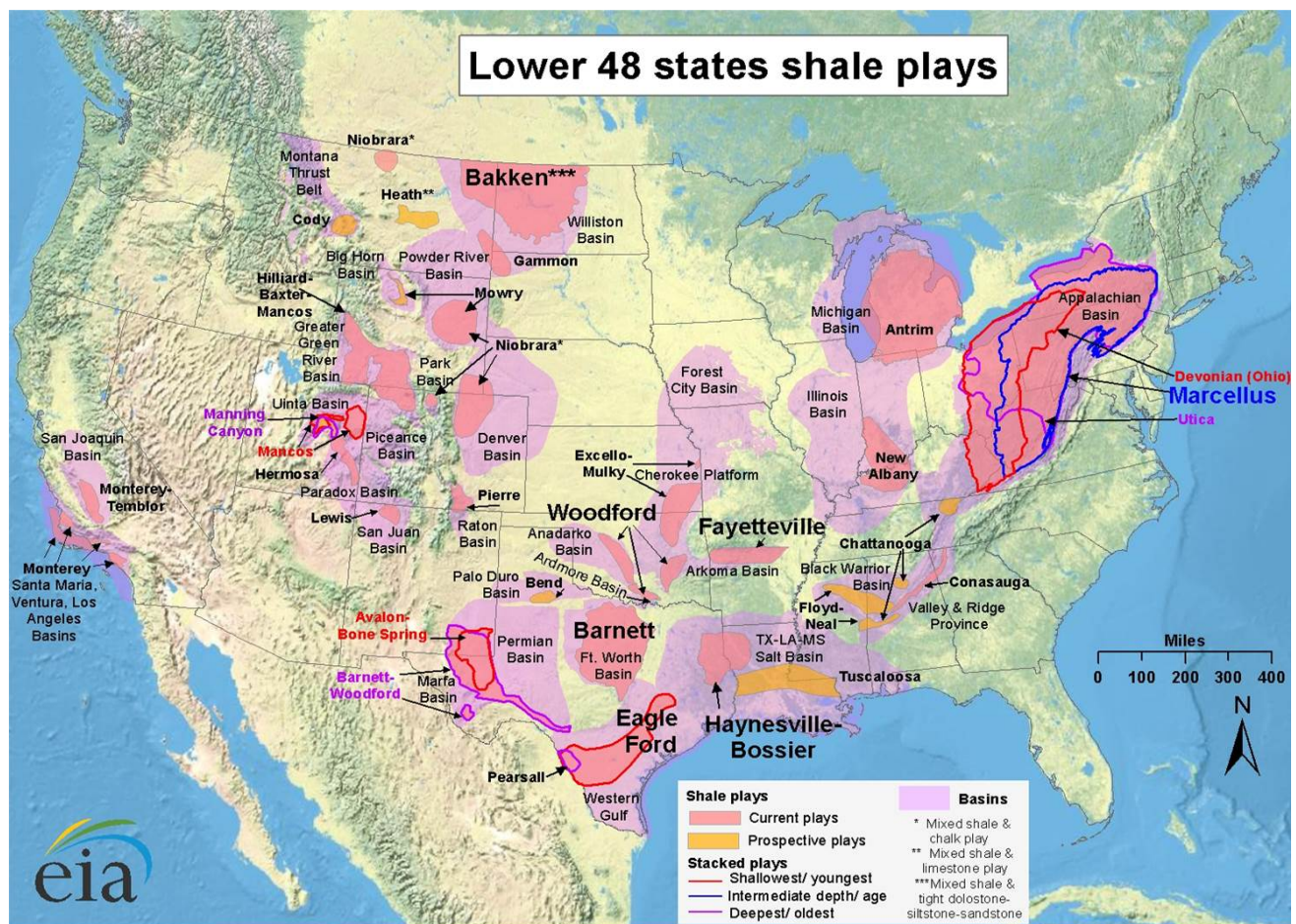


Figure 1: Source: Energy Information Administration based on data from various published studies, May 2001.

B. Procedure

Hydraulic fracturing involves spreading the fractures in a rock layer using pressurized fluids in order to release oil and gas that isn't economically viable to extract using traditional drilling techniques. First, a mile long vertical hole is drilled, and then a half mile long horizontal branch is drilled. A small package consisting of ball-bearing-like shrapnel and light explosives is sent into the drilled hole and detonated. The shrapnel punctures the bore hole allowing small perforations to open up in the pipe. Up to seven million gallons of slick water, “sand mixed with large volumes of freshwater that has been treated with a friction reducer such as a gel” (Harper, 2008), is pumped in the hole to fracture the shale rock, causing shale gas to be released. The water blasts through those perforations in the pipe into the shale at a force of more than nine thousand pounds of pressure per square inch and shatters the shale for a few yards on either “side of the pipe, allowing the gas embedded in it to rise under its own pressure and escape” (McKibben, 2012). Once the water is injected into the ground, it is then contaminated from exposure to oil and natural brines.

II. Economic Aspects of Hydraulic Fracturing

A. Benefits

Economists at Citigroup report that hydraulic fracturing will create up to 3.6 million new jobs by 2020 and will increase economic output in the United States by 2-3% per year (Foxman, 2012). There are many areas throughout the country that have been proposed for the practice, which would generate jobs. The practice also led to reduced reliance on foreign oil, has been a boon to energy-intensive industries like metals manufacture and fertilizer production, benefited the energy industry, and boosted the water-treatment business due to cleanup of recovered water (Trecker, 2012). Cheap natural gas displaced coal and is America's top source for electricity. The fracking industry is also bringing back jobs to once-decaying states like Ohio (Plummer,

2012). According to the publication ‘Rocky Mountain States Natural Gas: Resource Potential and Prerequisites to Expanded Production’ the energy resources of the Mountain West are significant to meeting the nation’s energy challenge, which is a resource problem, but encompasses underlying economic challenges (American Petroleum Institute, 2011).¹

B. Costs

Some of the direct costs associated with the practice of hydraulic fracturing are the regulation of the practice including compliance, knowledge, and monitoring. Regulation is a long term cost, but can offset larger and greater future costs that may rise if regulation is not implemented. Also, reporters of The Economist (2011) argue, “if natural gas is not produced cleanly, it will not prove to be so cheap either. Full disclosure is a price worth paying; however, this is a cost many gas producers do not want to incur. The cost of full disclosure is tied to the cost of regulation because disclosure of chemicals used in the process of hydraulic fracturing falls under disclosure laws. Some people may consider the displacement of coal as a benefit of hydraulic fracturing; however, it can also be considered a cost because “scientists are hotly debating just how much climate benefit actually comes from swapping out coal for natural gas, given that many gas wells and pipelines leak methane, a potent greenhouse gas” (Plummer, 2012). The leaking of methane will end up being a heavy cost to bear in the future if proper regulation surrounding gas wells and pipelines are not delineated in legislation. Often it is cheaper to prevent a negative occurrence from happening as opposed to treating it once it has taken place.

Government subsidies are also an element to look at when assessing the economic costs of hydraulic fracturing. The Gas Research Institute, overseen by federal regulators, was funded

¹ The publication was created by the Department of Energy (DOE).

partially by a Federal Energy Regulatory Commission approved surcharge on gas prices. The Gas Research Institute subsidized Mitchell Energy's first horizontal well in 1991. From 1980-2000, the Section 29 Tax Credit for Unconventional Gas incentivized shale gas drilling. This development took place right after Mitchell Energy successfully cracked the Barnett Shale in Texas. The first successful multi-fracture directional drill was completed by a joint DOE-private venture in 1986 (Trembath, 2012). The subsidization helped in the area of finding solutions to key technical problems that would not have been able to be achieved by private investors because of the risk involved. The subsidies incentivizing research and development have ended.

III. **Impacts**

Aside from assessing economic aspects, the environmental, human health, and social impacts that may result from the practice also need to be assessed. The practice as it stands can have negative impacts on the water, air, and land in communities surrounding hydraulic fracturing.

A. **Environmental Impacts**

i. Water

One aspect hydraulic fracturing operations do not consider when choosing a project site is the landscape surrounding the project's implementation. Many of the project sites are inland and "fracking uses a tremendous amount of water, a severely undervalued resource inland" (The Economist, 2011). Often the cost of hydraulic fracturing comes from the transportation of massive amounts of water to hydraulic fracturing sites. Since hydraulic fracturing involves injecting chemical laden water into the ground, some "communities are worried that the chemicals used to pry open the shale rock can contaminate nearby drinking water supplies" (Plummer, 2012). "In some fracking towns, people have been able to set their tap water on fire,"

(The Economist, 2011) aptly called the “flaming faucet” occurrence resulting from “methane migration and the chemicals mixed with water and then injected into fracking wells under high pressure” (McKibben, 2012). According to The Economist (2011), over 2,500 fracking products composed of 750 chemicals in the span of four year (2005-2009) were utilized by oil and gas companies, but “rigorous scientific study has been scant since 2000 allowing drilling companies to be exempt from federal safe drinking water statutes and hence not required to list the chemicals they push down wells” (McKibben, 2012). This was supported by Dick Cheney, the Vice President at the time (McKibben, 2012).

Apart from drinking water contamination, “the briny soup that pours out of the fracking wells in large volume can also affect rivers and streams”(McKibben, 2012). Even though most of the chemically loaded slick water injected into the wells stays belowground, “for every million gallons, [between] 200,000 to 400,000 gallons will be regurgitated back to the surface, bringing with it, not only the chemicals it included in the first place, but traces of the oil-laced drilling mud, and all the other noxious chemicals that were already trapped down there in the rock: iron and chromium, radium and [large quantities of] salt” (McKibben, 2012). The case of Dunkard Creek, a nature lovers’ haven which runs forty miles along the Pennsylvania – West Virginia border and with 161 aquatic species, shows that a disaster can result when bad water leaks into small streams. In September 2009 largely everything died in the course of a few days, except invasive microscopic algae that normally live in estuaries along the Texas coast. This bloom of “golden algae” killed everything else. The algae would have never bloomed in this region if the drilling companies would have been disposing their wastewater correctly. Because of the drilling companies’ illegal actions, Dunkard Creek turned into brine (McKibben, 2012).

This case study shows what a drastic negative effect this practice can have on the environment especially when there are no incentives in place to act the 'right' way.

ii. *Air*

Hydraulic fracturing produces "excess gas [which] is often vented off, producing air pollution" (Plummer, 2012) the process also "gives off methane, a potent heat-trapper" (The Economist, 2011). The EPA has reported that "oil and natural gas production and processing accounts for nearly 40 percent of all U.S. methane emissions" (Plummer, 2012). The oil and gas industry is the nation's biggest methane source. Natural gas development point and non-point sources contribute five times more benzene than any other emission source, including the likely benzene emission sources like on-road vehicles, wildfires, and wood burning (McKenzie, 2012).

Aside from the process itself polluting the air, fully constructed and prepared natural gas wells can also cause air pollution. For example in Wyoming the air quality standards no longer meet federal guidelines because of fumes seeping from the state's 27,000 wells, vapors that contain benzene and toluene (McKibben, 2012). According to a study led by Robert Howarth of Cornell University, "greenhouse-gas emissions over the life cycle of natural-gas production could actually be considerably higher than those of coal per unit of energy provided" (The Economist, 2011). This may be the case partly because "these methane emissions are at least 30% more than and perhaps more than twice as great as those from conventional gas" with the higher emissions from shale gas occurring when wells are hydraulically fractured -- as methane escapes from flow-back (Howarth, Santoro, & Ingraffea, 2011). These figures do not take into consideration that gas can be burned more efficiently than coal, which the supplementary material does note by stating,

Our estimate of GHG footprint of fuels does not include the efficiency of final use. If we examine electricity production, current power plants in the US are 30% to 37% efficient if powered by coal and 28% to 58% if powered by natural gas...When viewed on the 20-year time horizon, the GHG footprint for producing electricity from shale gas is 15% less than that for coal, when we

assume the lowest methane emissions and highest efficiency of use for producing electricity. However, at the high-end estimates for methane emissions the GHG footprint is 43% higher than that for coal even when burned at high efficiency (Howarth, Santoro, & Ingraffea, 2011).

Essentially, depending on the practices used during the preparation of wells, the actual extraction process, the transportation, and burning, emissions of greenhouse gasses can be more negligible than that of coal, or can be worse.

iii. Land

The Bureau of Land Management (BLM) conducted a study in 2006 and found that roughly 24 percent of public lands onshore (23.8 million acres) are accessible under standard industry lease terms and “based on current resource estimates, these lands are expected to contain 13 percent of the gas resources” (American Petroleum Institute, 2011). Approximately one-third of government lands have been set aside as national parks, wildlife refuges or wilderness areas all of which the oil and gas industry states they are not looking to explore for drilling, nor do they want to drill in wilderness areas where drilling is banned (American Petroleum Institute, 2011). Originally, the Interior Department proposed oil companies disclose the chemicals they intend to use in drilling before starting a well in order to acknowledge the concerns of landowners and communities about potential groundwater pollution (Broder, 2012). However, on May 4th, 2012 the Obama administration “proposed a rule governing hydraulic fracturing for oil and gas on public lands that will for the first time require disclosure of the chemicals used in the process” (Broder, 2012). The oil industry has received significant concessions with this proposed rule because “companies will have to reveal the composition of fluids only after they have completed drilling. This is a sharp change from the government’s original proposal, which would have required disclosure of the chemicals 30 days before a well could be started” (Broder, 2012).

Hydraulic fracturing has the potential to affect public infrastructure through induced earthquakes resulting from underground disposal of the process' wastewater. The National Research Council compiled a report identifying "eight cases in which seismic events were linked to wastewater disposal wells (not necessarily all for fracking wastes) in Ohio, Arkansas and Colorado" (Dutzik & Ridlington, 2012). Ohio generates and disposes more wastewater resulting from Marcellus shale drilling with "more than 500 million gallons of hydraulic fracturing wastewater disposed in underground wells in 2011" (Dutzik & Ridlington, 2012) than from any other source. The Youngstown area in Ohio also experienced a series of earthquakes in 2011, prompting Ohio officials to investigate potential links between the earthquakes and a nearby injection well. The results of the study did not conclusively link between the injection well and the earthquakes, but it found that "[a] number of coincidental circumstances appear to make a compelling argument for the recent Youngstown-area seismic events to have been induced (by the injection well)" (Dutzik & Ridlington, 2012). The earthquakes have not caused significant damage, but they raise concerns about the potential for damage to public infrastructure (such as water and sewer lines) as well as private property and the size and impact of the earthquakes are not predictable either (Dutzik & Ridlington, 2012).

B. Social/Health Impacts

It is increasingly common for natural gas development to occur near where people live, work, and play. A "review of 4,956 well locations revealed that 26% of the well locations reviewed are located 150 to 1,000 feet from a building intended for human occupancy, including homes, out buildings, businesses, residential living facilities, schools, and hospitals" (McKenzie, 2012) and "rigs have cropped up in backyards across the Northeast, as 11,400 new wells get drilled each year" (Plummer, 2012). This is a public health concern because the "the transport of

these air pollutants to nearby residences and population centers” (McKenzie, 2012) is significant and can cause cancer and non-cancer health risks.

i. Non-cancer health risks

Results from a study done indicate that the group of people who live near wells are affected more by non-cancer hazard index from air emissions due to extraction of natural gas. This was determined using a relatively short period, but high emissions are put off during the short well completion period. Exposure to trimethyl benzenes, alkanes, and xylenes primarily drives the hazard index (McKenzie, 2012). All of these chemicals have neurological and/or respiratory effects, such as leukemia, anemia, other blood disorders, and immunological effects. Inhalation of chemicals like trimethyl benzenes, xylenes, benzene, and alkanes can cause “dizziness, headaches, and fatigue at lower exposures to numbness in the limbs, incoordination, tremors, temporary limb paralysis, and unconsciousness at higher exposures” (McKenzie, 2012). These are all considered to be severe health risks.

ii. Cancer health risks

The EPA typically considers risks below 1 in a million to be so small as to be negligible. As with non-cancer health risks, the “cancer risk estimates were 10 in a million for residents near wells and 6 in a million for residents farther from wells” (McKenzie, 2012). These measurements are above a ‘negligible risk’ and should be avoided, especially if the federal lands proposed for use are in near proximity to residences or communities. As mentioned before, “the health effects resulting from air emissions during development of unconventional natural gas resources are most likely to occur in residents living nearest to the well pads during the short term well completion period and warrant further study” (McKenzie, 2012).

IV. Politics, Government Agencies & Legislation

One of the reasons strong legislation has not been imposed on the practice of hydraulic fracturing is reflected in part by the fact that people like Vice President Dick Cheney, whose former company Halliburton is a player in the fracking boom, did not pursue rigorous scientific study (McKibben, 2012). This is a classic conflict of interest that has stifled the implementation of regulation on the use of hydraulic fracturing to extract shale gas. Gas (and oil) companies are able to make use of many exemptions found in most major federal environmental laws. It has been asserted that the federal government (namely the Federal Power Commission, now the Federal Energy Regulatory Commission) was in collaboration with the gas industry to open the Gas Research Institute to develop new drilling and extraction methods. Because more research needed to be done, The Eastern Gas Shales Project of 1976, an initiative of the federal Energy Research and Development Administration, was implemented (Trembath, 2012). For these reasons, it is believed that the interconnectivity that exists limits how much the federal government is willing to impose regulation on the practice of hydraulic fracturing in shale rock.

A. The Safe Drinking Water Act

The most recent legislation that remotely addresses the practice of hydraulic fracturing is the *Safe Drinking Water Act*, with the most recent language added via the *Energy Policy Act* of 2005. The act states:

The term 'underground injection' – (A) means the subsurface emplacement of fluids by well injection; and (B) excludes – (i) the underground injection of natural gas for purposes of storage; and (ii) the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities (EPA, May 2012).

Fundamentally this excludes many of the procedures that do cause problems in the long run. It is often the underground injection of fluids or propping agents that have dire effects on surrounding habitats if certain equipment standards and practices are not met. One aspect that is regulated

heavily is the “use of diesel fuel during hydraulic fracturing” and “is still regulated by the UIC program” (EPA, May 2012). Ultimately, the act sets standards and requires permits for the underground injection of hazardous substances so that these materials do not endanger Underground Sources of Drinking Water (SDWA, 2008).

B. The Clean Water Act

The *Clean Water Act* (CWA) also has an influence on the practice of hydraulic fracturing. Companies have been able to drill under the act since 1980 with exemptions that set standards for storm water discharge despite the potential for significant runoff from thousands of well pads, pipelines and other infrastructure. Beginning in 1992, the EPA required storm water permits for oil and gas construction facilities of five acres or more. In the 2005 Energy Bill, Congress extended the exemption to all oil and gas construction facilities (Environmental Working Group, 2009). The CWA requires anyone who wants to discharge pollutants to first obtain a National Pollutant Discharge Elimination System (NPDES) permit; if the permit is not obtained, the discharge will be considered illegal. Therefore the “disposal of flowback [as a result of hydraulic fracturing] into surface waters of the United States is regulated by the National Pollutant Discharge Elimination System (NPDES) permit program, [which is authorized by] The Clean Water Act” (EPA, May 2012). The NPDES permit program is part of the office of wastewater management in the Water Permits Division (WPD) within the Environmental Protection Agency.

C. The Clean Air Act

The *Clean Air Act* limits emissions of nearly 190 toxic air pollutants, including emissions from oil and gas companies. The EPA must set standards for emissions of air toxics (hazardous air pollutants). Air toxics are known or suspected of causing cancer and other serious health

effects. Aside from setting standards, the EPA must conduct a residual risk review & technology reviews of these air toxic emission standards one time, eight years after the standards were issued. As it stands now “existing air toxics standards for oil and natural gas production, and the standards for natural gas transmission and storage were issued in 1999” (EPA, April 2012). Drilling sites are not treated as an aggregated unit under the Clean Air Act, even though typically, smaller sources of emissions grouped together that produce pollution above certain thresholds are treated as such.

D. The Comprehensive, Response, Compensation, and Liability Act

Another act that relates to the process of hydraulic fracturing is the *Comprehensive, Response, Compensation, and Liability Act* (CERCLA); this act holds most industries accountable for cleaning up hazardous waste. Unfortunately, many wells are exempt from CERCLA. The law was passed in 1980 and amended in 1986 and allows the federal government to respond to releases of hazardous substances that threaten human health or the environment. A trust fund (Superfund) was created and its purpose was to clean up contaminated sites. Initially, the fund was financed via taxes on the chemical and petroleum industries, but Congress abolished the taxes and the fund is paid for through general revenues. This results in a fund that is too small to meet cleanup goals. Because the liability exemption for drilling companies remains (Mall et al., 2007), the superfund allows Potentially Responsible Parties (PRPs) to be held responsible for clean-up costs for a release or threatened release of a “hazardous substance,” but the law defines this as excluding oil and natural gas (CERCLA, 2008). Accordingly, the industry has little incentive to clean up its hazardous waste or to minimize leaks and spills, which often results in “cut and run” jobs leaving communities to clean up the pollution left behind. Likewise, according to the *National Environmental Policy Act* of 1969 (NEPA), certain gas

drilling activities are exempt, including hydraulic fracturing, eliminating the need to conduct environmental impact statements. This shifts the burden of proof onto the public to determine whether public safety is at risk.

E. The Fracturing Responsibility and Awareness Of Chemicals Act

Finally in 2009, *The Fracturing Responsibility and Awareness of Chemicals Act* (FRAC Act) was introduced to both houses of Congress on June 9, 2009 (111th Congress). The aim of this act is to define hydraulic fracturing as a regulated activity under the Safe Drinking Water Act. The energy industry would be required to disclose chemicals it mixes in its mixture of water, sand, and proppants². This bill was never enacted, but the 112th Congress reintroduced the bill on March 15, 2011 and it was referred to committee. The congressional committee “will consider it before sending it on to the House or Senate as a whole” (Govtrack).

In spite of the lack of regulation on this practice for the next two years all gas producers will have to at the very least burn or flare their wasted gas which will reduce hazardous compounds by 95 percent. Then, starting in 2015, all gas producers will have to undertake a more comprehensive strategy known as “green completion,” in which leaked and vented gas is captured to resell (Plummer, 2012). However, when the government proposed chemical disclosure rules mandating disclosure thirty days before operation began, “the industry objected, saying that the additional paperwork would slow the permitting process and potentially jeopardize trade secrets. The government then agreed to allow companies to reveal the contents of drilling fluids after the operation had been completed” (Broder, 2012). The reasoning given by officials at the Department of Interior is that having a record would allow scientists to trace

² The EPA defines proppants by their usage, which is to “prop open a hydraulic fracture. An ideal proppant should produce maximum permeability in a fracture. Fracture permeability is a function of proppant grain roundness, proppant purity, and crush strength. Larger proppant volumes allow for wider fractures, which facilitate more rapid flowback to the production well” (EPA 2004).

any future contamination and the time of disclosure of fluid composition is irrelevant (Broder, 2012).

At this time, in the absence of federal oversight, the only regulatory action that has been implemented in any rigorous manner has been at the state level. The Center for Energy Economics and Policy conducted a study in order to “provide an overview of the regulatory patterns, similarities, and differences among states” (CEEP, 2012). Many states have either local bans and moratoria or statewide moratoriums on various parts of the horizontal drilling and hydraulic fracturing process. For example, New York State has statewide moratorium as well as more than 50 local bans and moratoria. Many states that have implemented local or municipal bans are in the midst of legal proceedings over the legality of local regulation of shale gas extraction (CEEP, 2012). Some regulators and constituents think the regulation of shale gas extraction should be left up to the state governments since they have more resources than local governments. Two New York judges recently upheld local ordinances banning the practice (CEEP, 2012); West Virginia shows a different story where a judge ruled a local ordinance unconstitutional and unenforceable (CEEP, 2012). Although Texas and Colorado do not allow local or municipal bans, several local governments in these states passed moratoria on the shale gas development process (CEEP, 2012). The moratorium in New Jersey is set to expire in December 2012 and Maryland’s in June 2014 (CEEP, 2012). North Carolina passed legislation in 2012 allowing horizontal drilling, but will not be allowed to commence until a regulatory framework is in place (CEEP, 2012). The regulatory framework should occur sometime in the next two years (CEEP, 2012). However, of the thirty-one states in the study, eighteen states did not have any bans or moratoria on the practice, as seen in Figure 2.

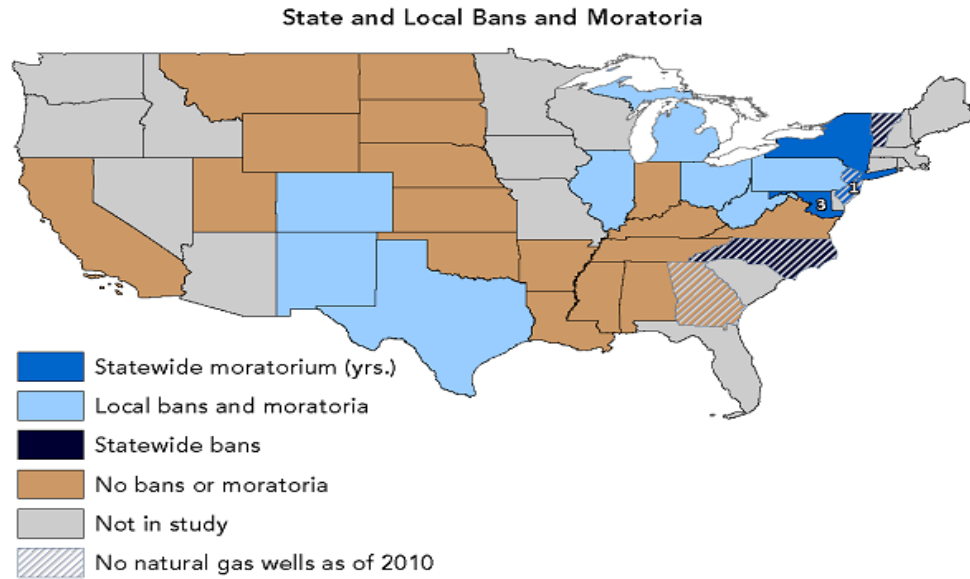


Figure 2: Source: Resources for the Future, 2012.

F. Litigation

In January 2009 Wild Earth Guardians and the San Juan Citizens Alliance sued the EPA, alleging that the Agency “had failed to review the new source performance standards and the major source air toxic standards for the oil and natural gas industry” (EPA, April 2012). New Source Performance Standards (NSPS) need to be specified for industrial categories that “cause, or significantly contribute to, air pollution that may endanger public health or welfare” by the EPA according to the Clean Air Act. The “EPA is required to review these standards every eight years; the existing NSPS – for VOCs and SO₂ – were issued in 1985” (EPA, April 2012).

V. **Alternatives & Recommendation**

Many opponents of hydraulic fracturing think banning the practice is the most practical solution because of the associated negative environmental and social impacts. The implications of banning hydraulic fracturing are a continued reliance on foreign oil, the further development and use of coal, and the stagnation of the oil and gas industry within the United States.

Economically speaking, the banning of the practice would reduce the amount of state and local taxes received from the industry as well as taxes that would come from the labor force.

As a result of the many negative externalities that have been found as a result of hydraulic fracturing, groups like the Natural Resources Defense Council are pushing the EPA to regulate methane directly. They argue there are a slew of proven technologies to limit methane leaks from natural gas production (Plummer, 2012) and should be utilized. Instead of banning the practice, technologies that are technically feasible and commercially profitable can be used in order to mitigate the risks that come with the practice. However in order to mitigate the risk the alterations to technology would need to be comprehensive. If this is done, then 80% of the methane emitted can be captured and “the oil & gas industry can generate \$2 billion in additional revenue from these methane savings” (Gowrishankar, 2012).

One technology that is looked at is “green completions”. This technology prevents vented, leaked or otherwise wasted natural gas from seeping through the wells as they are being stimulated and readied for natural gas extraction. According to the EPA, “green completions, (reduced emission completions/RECs) continue to be identified as the best system of emission reduction, but a transition period was put in place (until January 1, 2015) to ensure green completion equipment is broadly available” (Gowrishankar, 2012). During the transition period, emissions must be reduced by using combustion devices and flaring. The practice of green completion yields a nearly 95 percent reduction in volatile organic compounds (EPA, April 2012). In the meantime, the wasteful practice of flaring needs to occur, but eliminates many of the volatile organic compounds.

Other tools to be used in conjunction with green completion technologies are: plunger lift systems³, TEG dehydrator emission controls⁴, desiccant dehydrators⁵, dry seal systems⁶, improved compressor maintenance⁷, low-bleed or no-bleed pneumatic controllers⁸, adequate pipeline maintenance and repair⁹, and vapor recovery units¹⁰ (Gowrishankar, 2012). Aside from these tools that can be used in juxtaposition with green completion technology, leak monitoring and consistent leak repair policies need to be implemented to detect and capture methane leaks, which are typically colorless and odorless. These leaks may come from numerous locations at an oil & gas facility, so using advanced leak monitoring equipment and enhanced operational practices would be beneficial to all actors involved in this process (Gowrishankar, 2012).

These methods do not address the other concerns that accompany hydraulic fracturing. Regulation would also need to address wastewater disposal and determine what the least impactful method would be. For instance, wastewater can be captured in huge on-site tanks and pushed back down “injection wells,” however this process apparently triggered the temblor in Youngstown.¹¹ This process also leaves behind large quantities of salty residue, which is not

³Plunger lift systems are used to remove blockages caused by liquids accumulation in older wells, in a way that captures methane from being released into the atmosphere (Gowrishankar, 2012).

⁴TEG dehydrators reduce methane leakage (they remove moisture from natural gas before it is transported) by using additional equipment and process optimization (Gowrishankar, 2012).

⁵Desiccant dehydrators would nearly eliminate methane leakage during the process of removing moisture from natural gas, with the use of special water-absorbing salts (Gowrishankar, 2012).

⁶Dry seal systems mitigate methane leakage from centrifugal compressors, which are used during natural gas processing and pipeline transportation, with the use of more effective seals (Gowrishankar, 2012).

⁷Improved maintenance controls the leakage from reciprocating compressors, through timely rod packing replacements (Gowrishankar, 2012).

⁸Switching to low bleed or no bleed controllers limits the leakage from pneumatic controllers, which control gas pressure and flow, with the use of special reduced-leakage systems (Gowrishankar, 2012).

⁹This allows for methane flowing through pipelines to be captured while problems in pipelines are fixed (Gowrishankar, 2012).

¹⁰These capture methane leaked from crude oil when it is stored in tanks (Gowrishankar, 2012).

¹¹“On New Year’s Eve of 2011 a magnitude 4.0 earthquake in Youngstown, Ohio, was blamed on the injection of high-pressure fracking water along a seismic fault, a phenomenon also documented in Arkansas and Oklahoma.” (McKibben, 2012). As a result, state officials shut down all drilling around a brine-injection well. “That was the 11th earthquake in 2011 in the region, which is not considered seismically active” (Niiler, 2012).

ideal, since other methods of disposal are just as bad. Furthermore, the wells can keep oozing out their toxic load for many years after drilling is done (McKibben, 2012).

Earthquakes, though not preventable when using the practice, can be reduced or mitigated through implementation of “a traffic light system; operators would have to monitor tremors and if they started to get bigger fracking would have to stop. They would also have to avoid fracking near known active faults” (Stephenson, 2012). As far as health risk prevention goes, efforts should be directed towards reducing air emission exposures for people living and working near wells during well completions (McKenzie, 2012). Federal or state regulations should ensure that hydraulic fracturing is not near residences, schools, or hospitals since near proximity to projects have shown to increase cancer and non-cancer risks. If the shale gas can only be accessed via residential areas or near schools or hospitals, then it needs to be determined whether the entire public benefit (and company benefit) that comes from extracting natural gas outweighs the right to property and whether eminent domain should be applied. In such cases fair market value for properties would be payable to property owners.

VI. Conclusion

The patchwork of policies that exist primarily on a state to state basis is no longer the way hydraulic fracturing should be regulated because it is not effective, especially when some states have no regulation on some of the procedures involved in the process. Given the amount of time the practice has been in existence, the federal government had plenty of time to conduct studies in order to protect not only the constituents of the United States, but to also protect the environment. However, a reasonable time frame needs to be offered to the industry in order to ensure appropriate technologies are implemented properly to mitigate risks and to ensure maintenance of facilities is kept to stringent standards. Disjointed policies that do not connect

with one another ultimately do not reflect the underlying connection between policies, economics, the environment, people, and the future of the earth. This should not be the way business is done; rather, the underlying connections are often the most valuable sets of information which can be used when formulating fluid policies that work together.

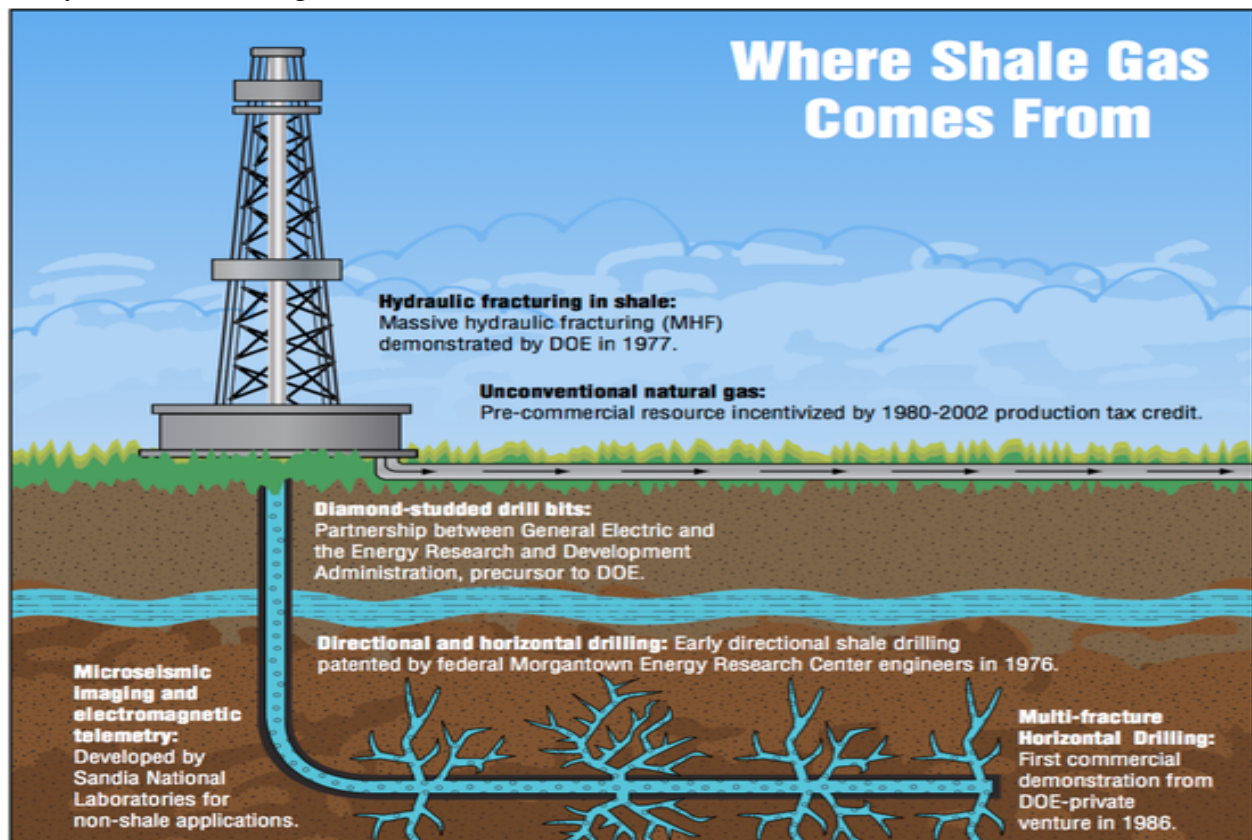
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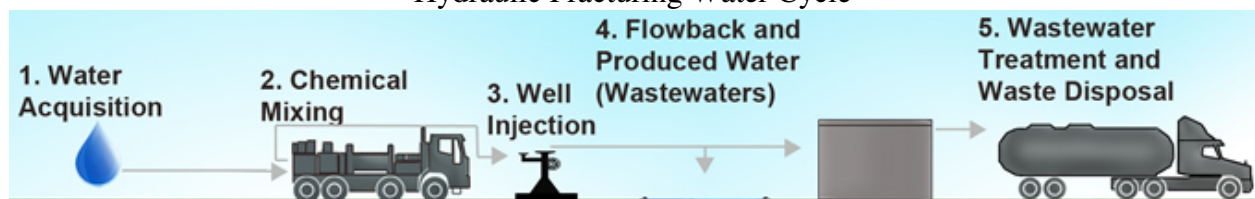
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Index of photos to accompany explanations found in the section entitled The History & Process of Hydraulic Fracturing



Source: The Breakthrough Institute

Hydraulic Fracturing Water Cycle



Source: Environmental Protection Agency